Accelerated Bridge Construction

James McMinimee

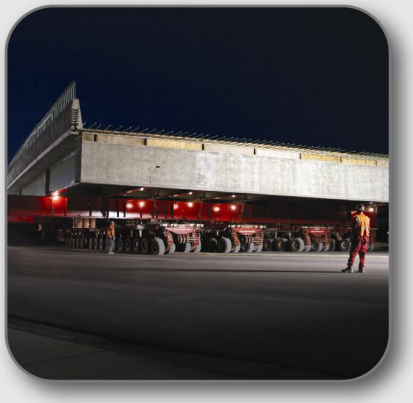
Applied Research Associates; Principal Engineer

Carmen Swanwick

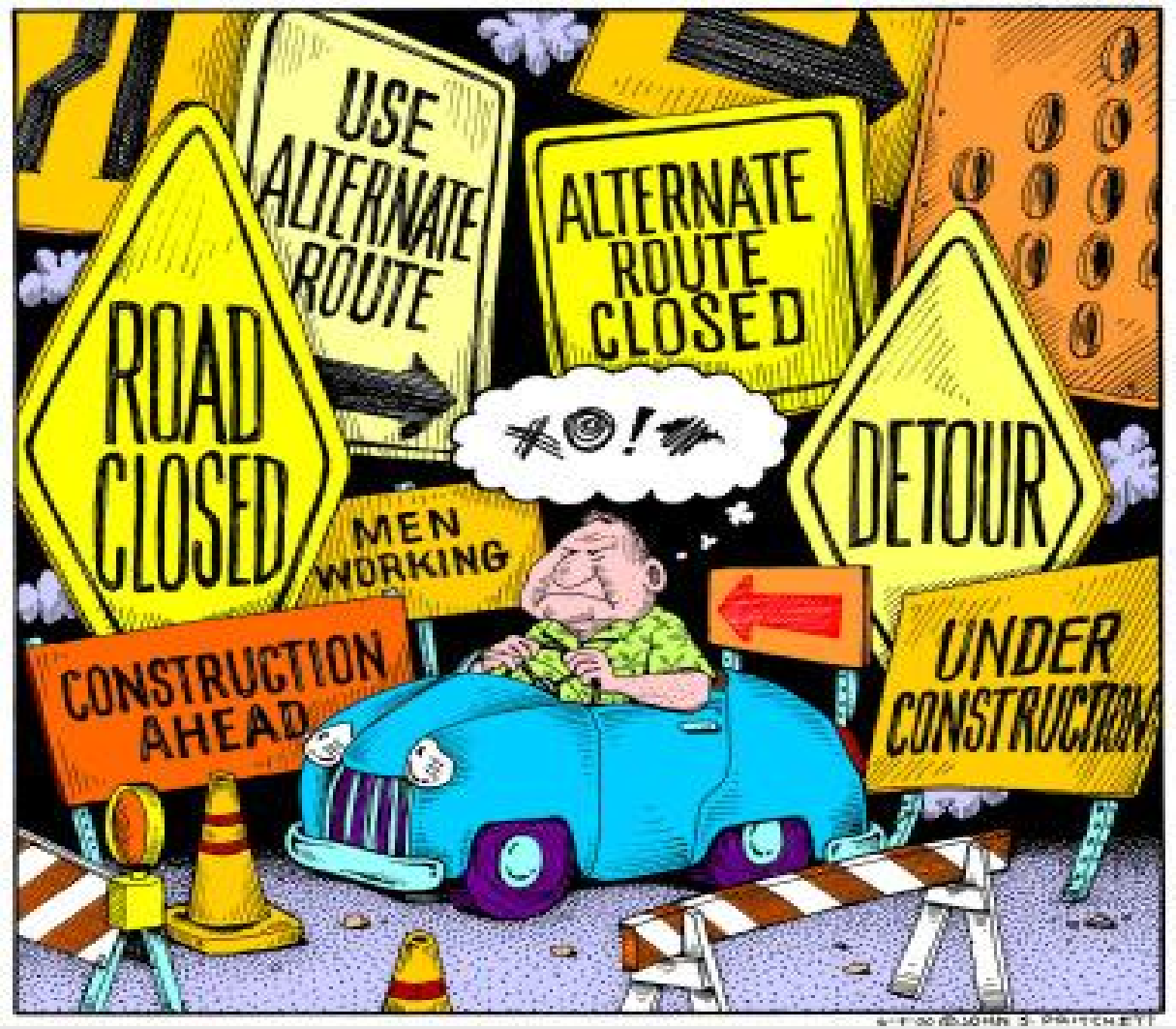
UDOT; Chief Structural Engineer

Paul Blackham

Stanley Consultants;
Principal Structural Engineer

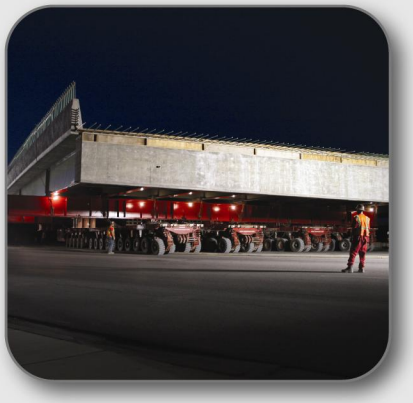


Reduce the Impact to Traveling Public



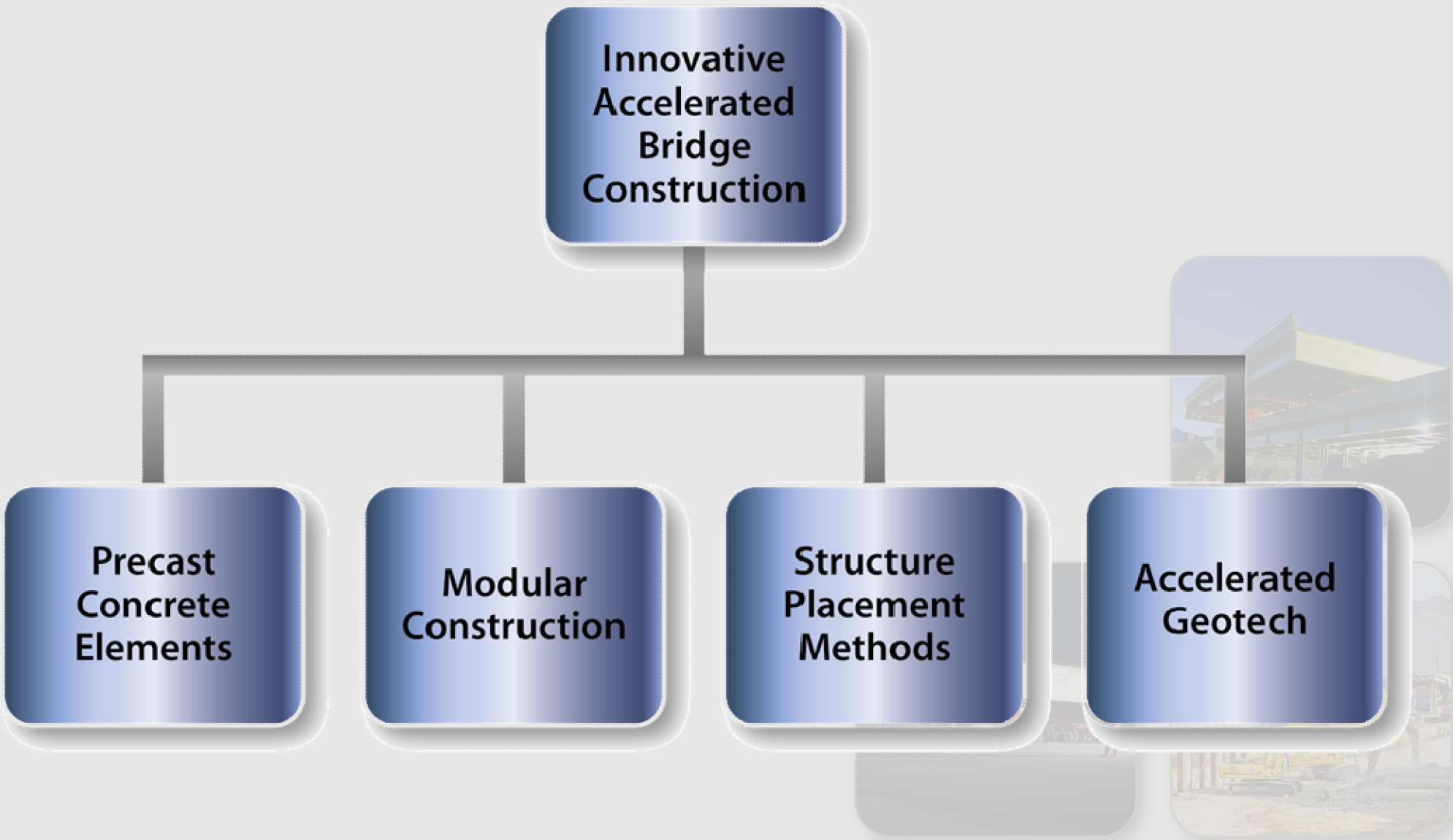
What is ABC?

- Innovative methods to decrease bridge construction time
- Prefabricated bridge elements and systems
- Self Propelled Modular Transporters (SPMT)



Family of Innovative ABC

Elements and Methods



Precast Concrete Elements

I-80; Wanship Bridge

- First project constructed in 2003
- Full depth precast panels

Modular Construction

I-215 over 3670 South

- Second project constructed in 2004
- Deck precast on steel girders
- Crane placement
- Post tensioned transversely

Structure Placement Methods

- Self Propelled Modular Transporters (SPMT)
- Slide-in/skidding
- Launching
- Crane placement

Structure Placement Methods

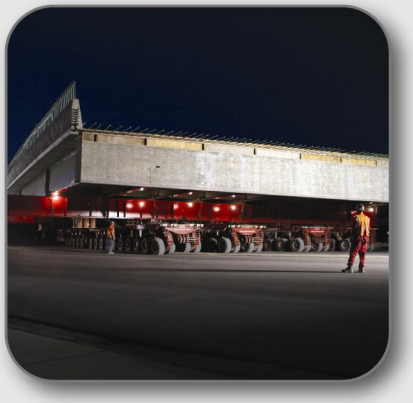
Staging Areas

Accelerated Geotechnical

Geofoam Embankment

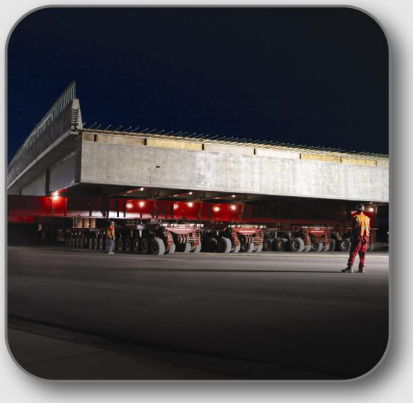
Innovative Contracting

- Design-Build
- Construction Manager General Contractor (CMGC)



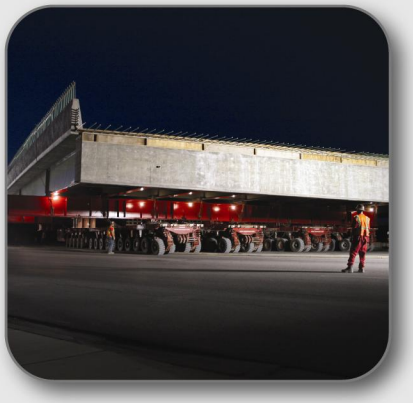
Benefits of ABC

- Minimized traffic disruption – from months to days
- Improved work zone safety – improved worker safety
- Improved product quality – controlled environment, cure times, easier access

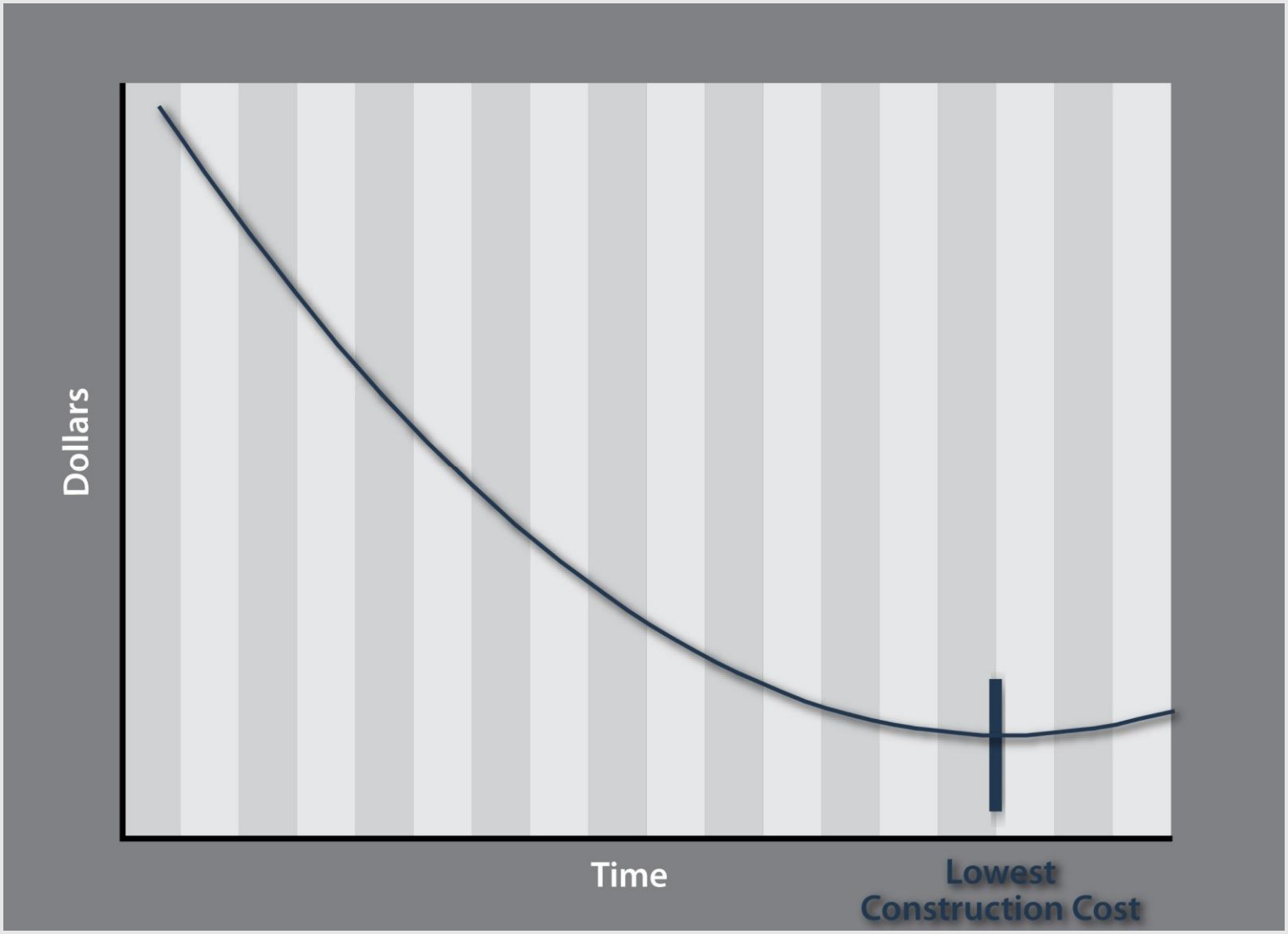


Market Direction to Policy Makers

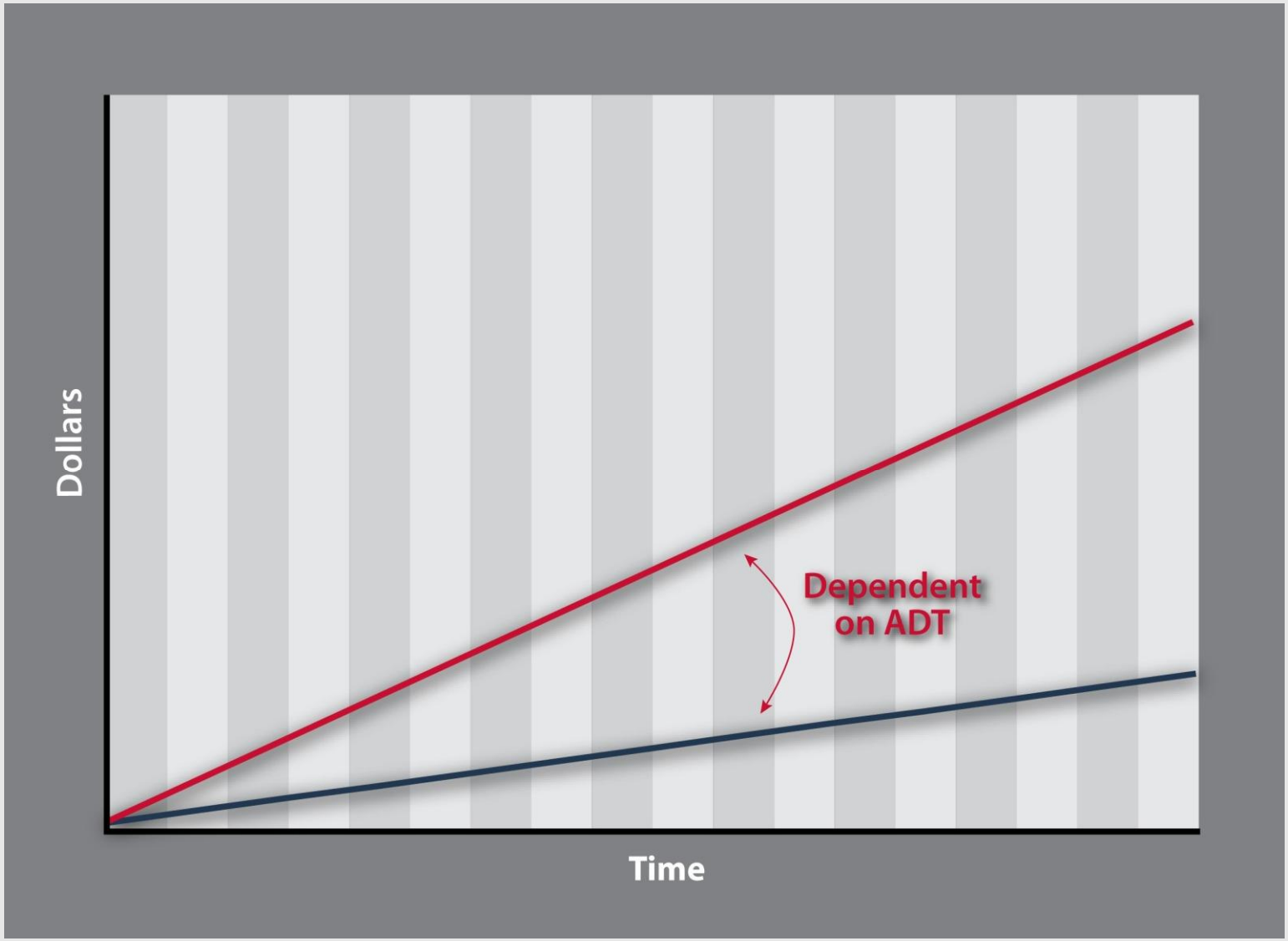
- Paradigm shift
- Strategy for implementation
- Communication/messaging plan



Traditional Cost Curve for Construction Projects

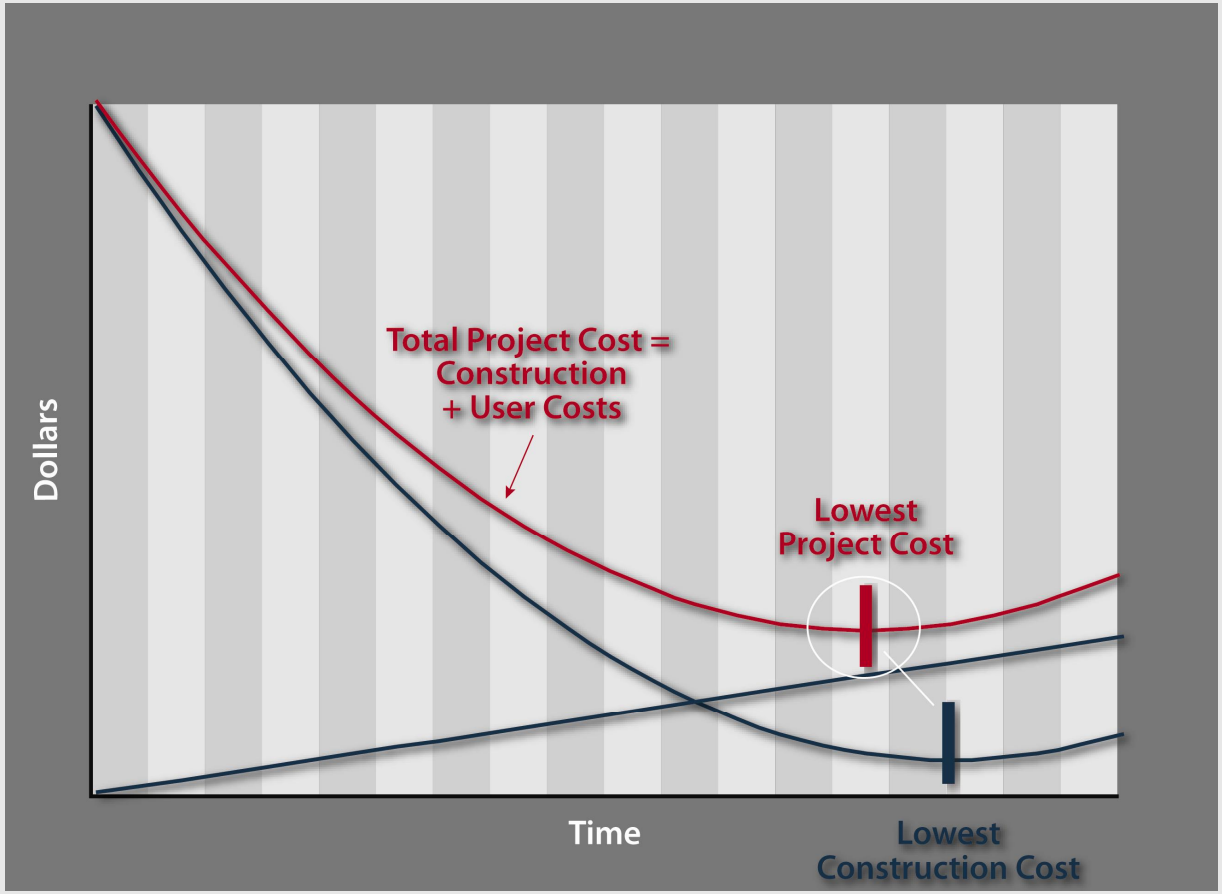


User Costs vs. Time in Work Zones



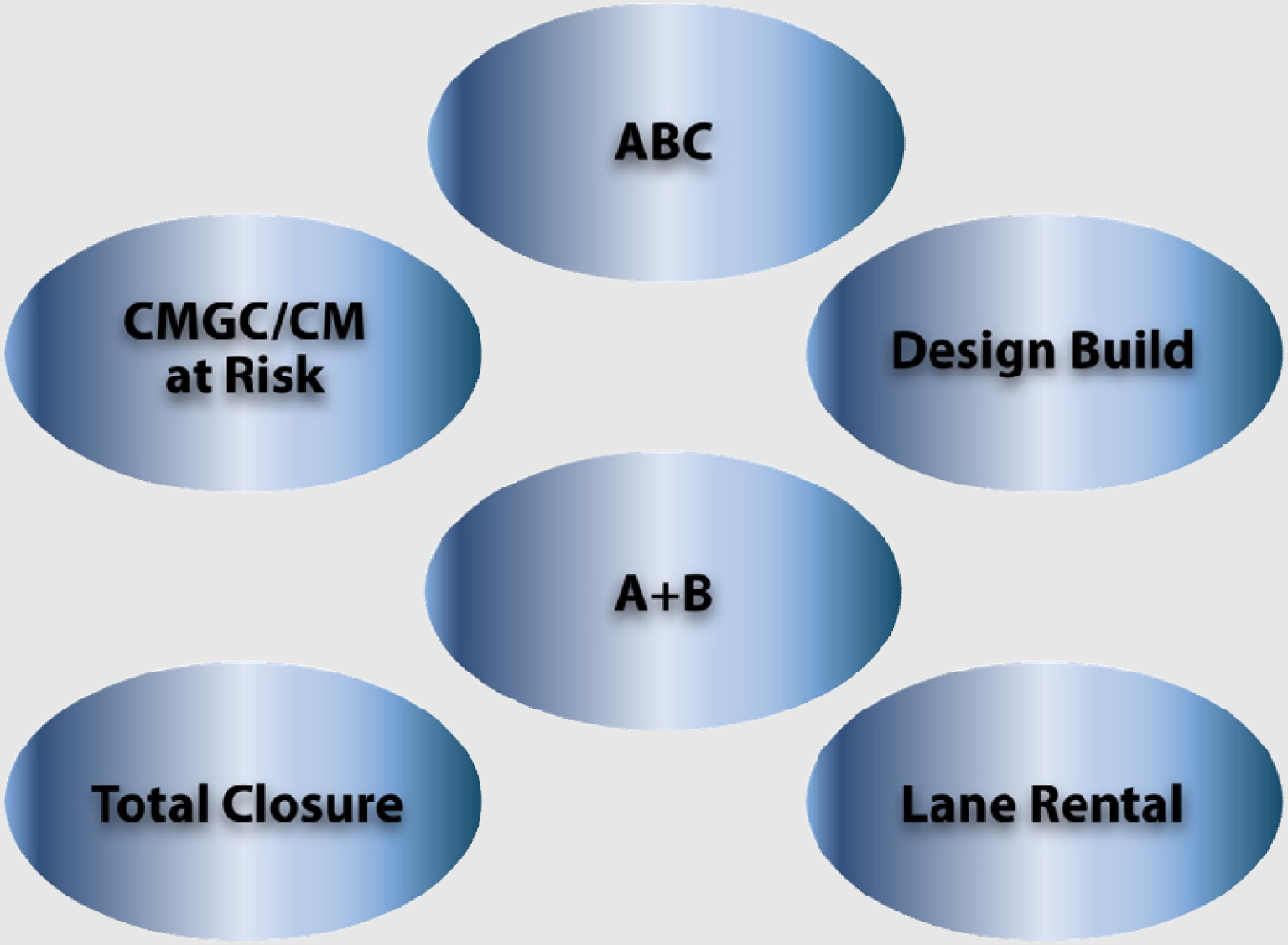
New Business Model

- New paradigm
- Lowest construction cost ⟹ lowest project cost
- Societal costs minimized
- Public support
- Political capital



Strategy for Implementation

Program Delivery



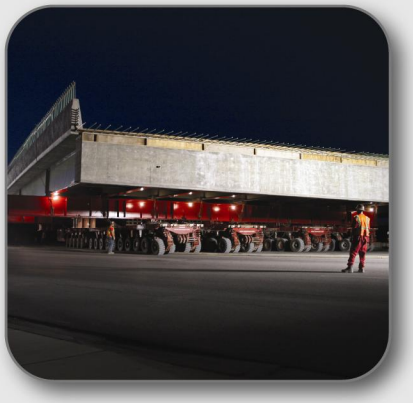
Strategy for Implementation

Project Delivery

- Prescriptive projects – gain experience
  - Design-Bid-Build
  - CMGC
- Performance projects – innovations led by contractor
  - Design-Build

Implementation Ideas

- Scanning tours
- Pilot project
- Lessons learned
- Best practices

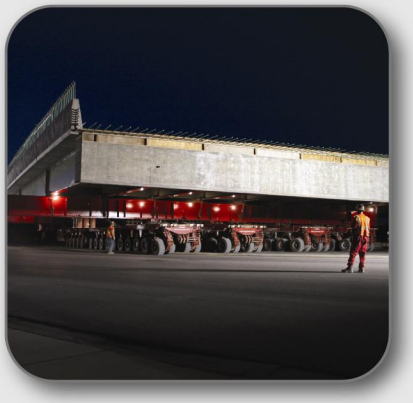


Scanning Tours With Industry

- Market internal and external
- Conduct workshops
- Perform scanning tours with industry

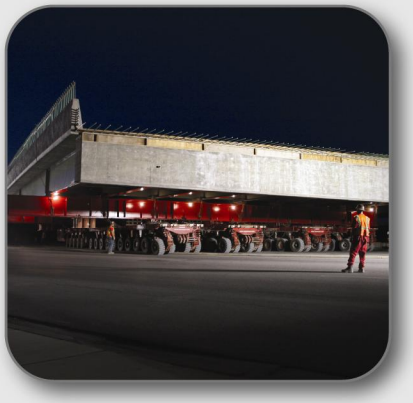
Pilot Project

- Obtain senior leadership involvement
- Promote marketing and media plan
- Develop messaging
- Prepare visual animation



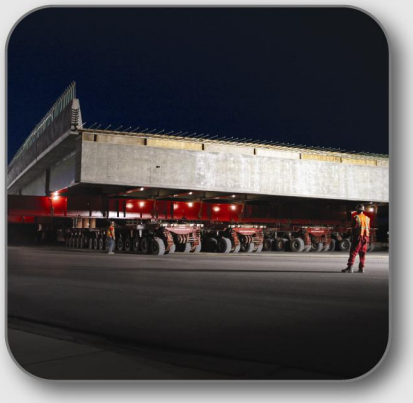
Lessons Learned

- Perform program review
- Find program flaws
- Repair flaws
- Review design decisions
- Measure design assumptions vs. reality



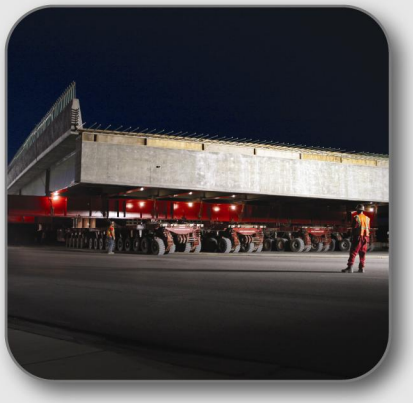
Best Practices

- Identify a program of projects
- Perform scanning tours
- Get involved nationally
- Implement standardization
- Educate and communicate within the industry



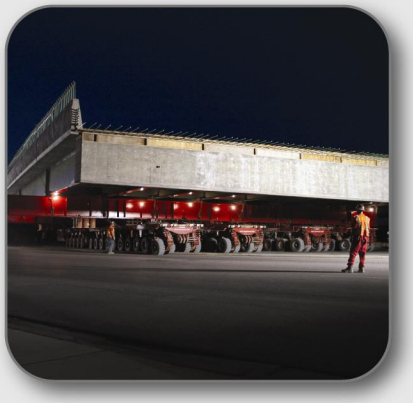
Cultural Shift

- Regions and contractors are using and improving innovation without central prompting
- ABC techniques are standard practice in projects



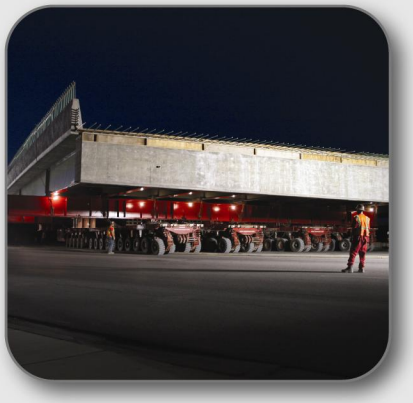
Utah's ABC Program and Projects

- UDOT Themes
- Timeline / History
- Structures Program
- ABC Program
- Projects
- ABC Costs / Value

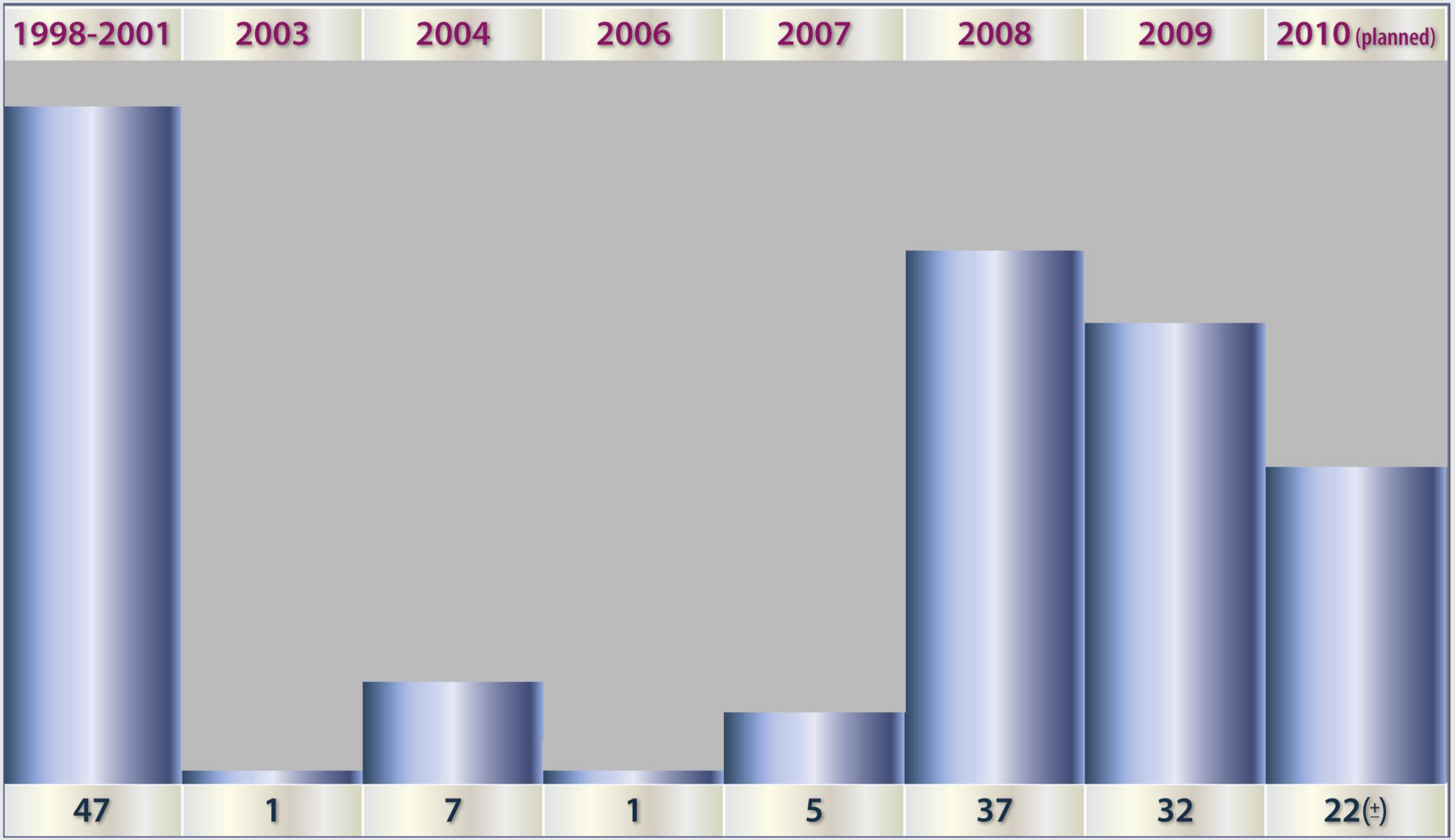


UDOT Themes

- Accelerate project delivery
- Minimize impacts to traffic/public
- Encourage innovation
- Get a good price



Timeline of ABC

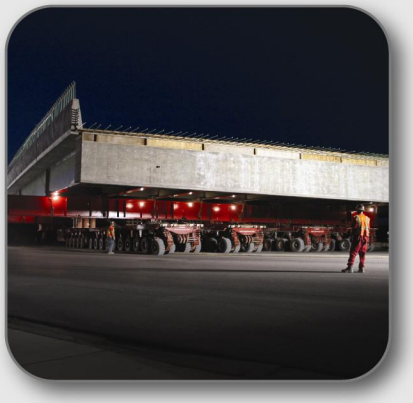


UDOT ABC History

ABC Method/Element	Bridges
Self Propelled Modular Transporters (SPMT)	18
Slide-in	5
Heavy Lift Cranes	3
Half Depth Precast Deck Panels	64 (+)
Full Depth Precast Deck Panels	32
Precast Voided Slabs	2
Approach Slab Panels	17
Precast Sleeper Slabs	17
Precast Abutments	5
Precast Bent Caps	3
Precast Columns	1
Prefabricated Pedestrian Bridge	4
Precast Box Culvert	41

Structures Program

- Implement an ABC program with project delivery
- Develop guidelines for ABC project inclusion
- Develop typical details and manuals
- Include user costs in analysis
- Encourage innovation
- Track lessons learned
- Provide training and educate



ABC Program

Utah Department of Transportation
4501 South 2700 West
Salt Lake City, UT 84114

Project:	Hypothetical Bridge Project		
By:	MPC	Checked:	BLB
Date:	5/11/2010		5/11/2010
Sheet No.	1	of	3

Utah ABC Decision Chart — **May 2010**

Enter values for each aspect of the project. Attach back-up data if applicable

Average Daily Traffic	5	1	Less than 5000
Combined on and under		2	5000 to 10000
Enter 5 for Interstate Highways		3	10000 to 15000
		4	15000 to 20000
		5	More than 20000
Detour Time	2	1	Less than 5 minutes
		2	5-10 minutes
		3	10-15 minutes
		4	15-20 minutes
		5	More than 20 minutes
Evacuation Route?	0	0	No
		5	Yes
User Costs	4	1	Less than $5000 per day
		2	$5000 to $7000
		3	$7000 to $10000
		4	$10000 to $12000
		5	More than $12000
Economy of Scale	2	1	1 span
(total number of spans)		2	2 to 3 spans
		3	4 to 5 spans
		4	6 to 7 spans
		5	More than 7 spans
Use of Standards	1	1	Custom Bridge
		2	25% of elements are applicable to standards
		3	50% of elements are applicable to standards
		4	75% of elements are applicable to standards
		5	Majority of elements are applicable to Standards
Worker Safety	5	1	Majority of work behind concrete barriers (out of traffic)
		2	25% of work behind signs/barrels/cones (exposed to traffic)
		3	50% of work behind signs/barrels/cones (exposed to traffic)
		4	75% of work behind signs/barrels/cones (exposed to traffic)
		5	Majority of work behind signs/barrels/cones (exposed to traffic)
Environmental Issues	1	1	Minimal to no environmental impacts
		2	
		3	Moderate impact site
		4	
		5	High Value Site

Utah Department of Transportation
4501 South 2700 West
Salt Lake City, UT 84114

Project:	Hypothetical Bridge Project		
By:	MPC	Checked:	BLB
Date:	5/11/2010		5/11/2010
Sheet No.	2	of	3

Utah ABC Decision Calculation — **May 2010**

Railroad Impacts	0	0	No Railroad
		1	Freight Siding (Less than 1 train per week)
		2	Light Freight (1 Train per week to 1 Train per day)
		3	Heavy Freight (More than 1 Train per day)
		4	Commuter rail
		5	Electrified Commuter Rail
Weather Limitations	1	1	Arid environment
		2	
		3	Normal weather (valleys)
		4	
		5	Extreme weather (mountains, limited construction season)

ABC Rating

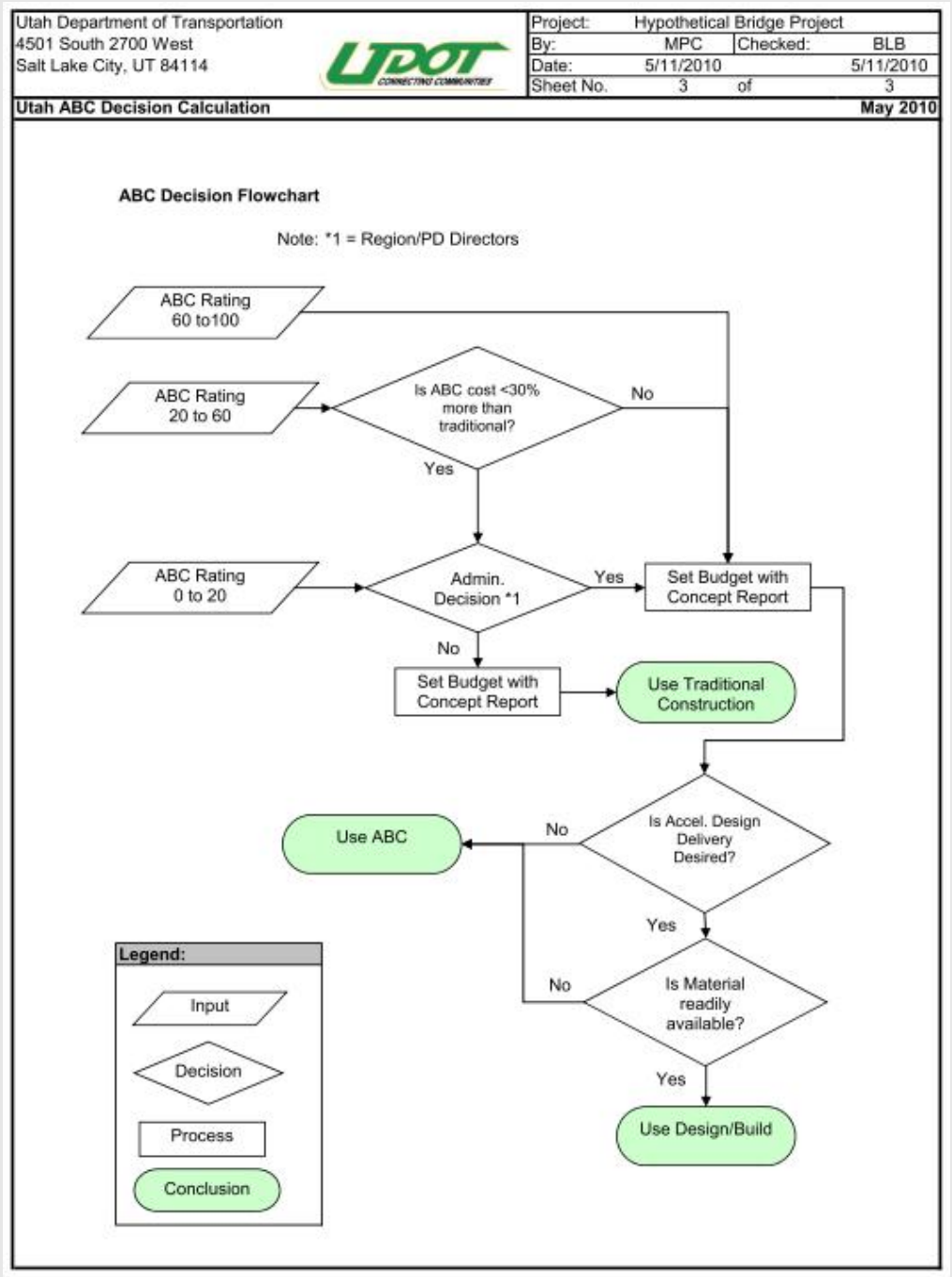
	Score	Weight Factor	Adjusted Score
Average Daily Traffic	5	10	50
Detour Time	2	10	20
Evacuation Route?	0	4	0
User Costs	4	10	40
Economy of Scale	2	3	6
Use of Standards	1	3	3
Worker Safety	5	8	40
Environmental Issues	1	3	3
Railroad Impacts	0	5	0
Weather Limitations	1	3	3
		Total Score	165
		Maximum Score	295

ABC Rating	**56**

ABC Rating Scale	
60-100	ABC should be used
20-60	ABC should be considered
0-20	ABC not recommended

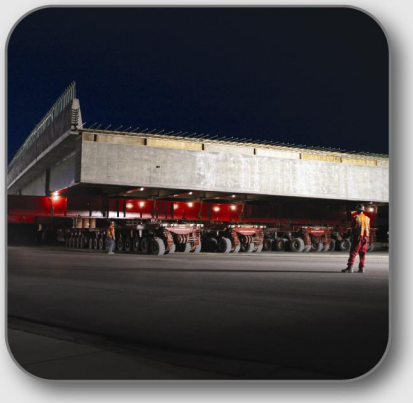
Note: Weight factors determined by UDOT. Do not adjust factors without prior consultation

ABC Program


Utah Department of Transportation
4501 South 2700 West
Salt Lake City, UT 84114
Project: Hypothetical Bridge Project
By: MPC
Checked: BLB
Date: 5/11/2010
5/11/2010
Sheet No. 3 of 3
Utah ABC Decision Calculation
May 2010
ABC Decision Flowchart
Note: *1 = Region/PD Directors
ABC Rating 60 to100
ABC Rating 20 to 60
Is ABC cost <30% more than traditional?
No
Yes
ABC Rating 0 to 20
Admin. Decision *1
Yes
Set Budget with Concept Report
No
Set Budget with Concept Report
Use Traditional Construction
Is Accel. Design Delivery Desired?
No
Use ABC
Yes
No
Is Material readily available?
Yes
Use Design/Build
Legend:
Input
Decision
Process
Conclusion

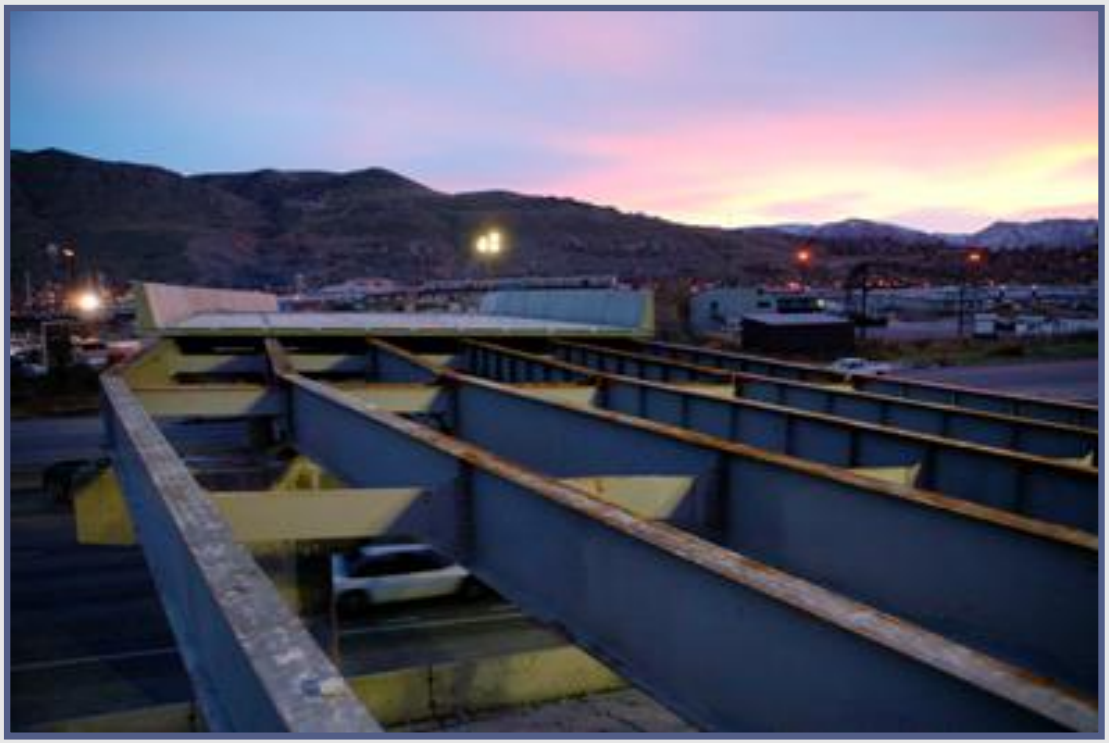
ABC Program

- Design manuals
- Typical details
- Specifications
- SPMT process manual
- Training
- Innovative contracting



Projects

800 North over I-15; Precast Deck Panels; CMGC

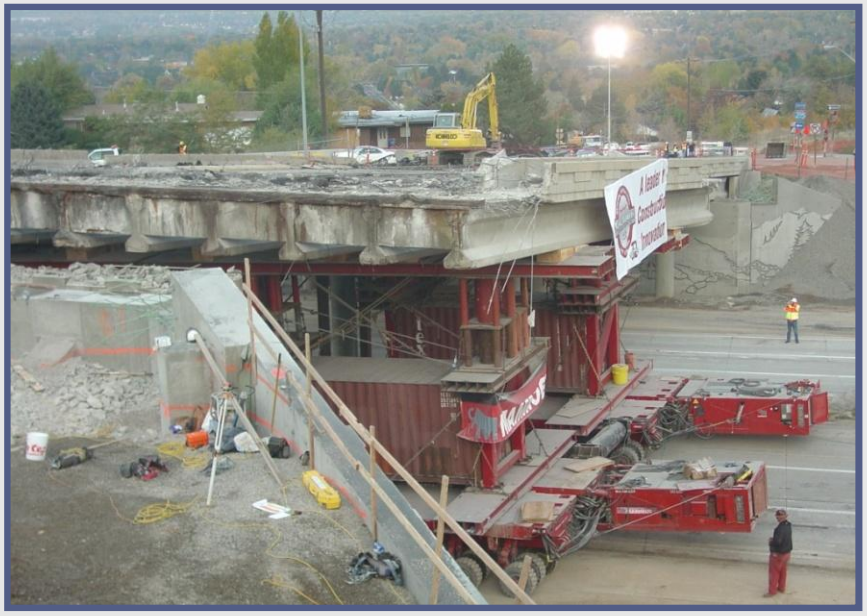


Projects

Riverdale Road over I-84 ; Lego Bridge; CMGC

Projects

4500 South over I-215; SPMT; CMGC



Projects

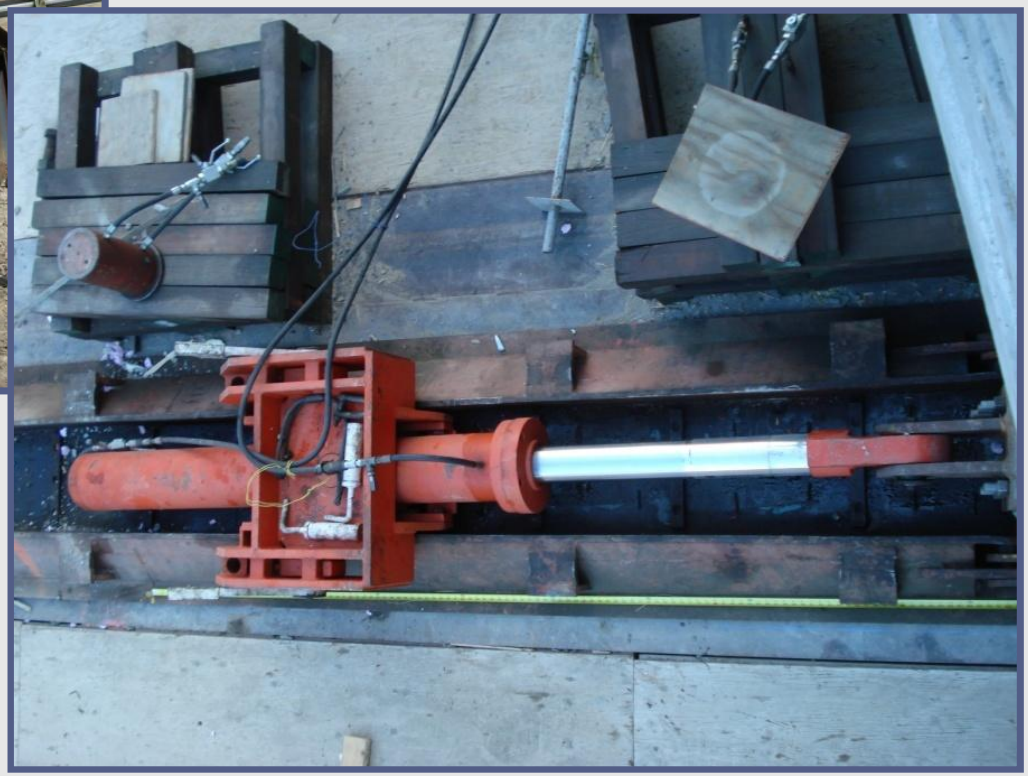
I-80; State Street to 1300 East; SPMT; CMGC

Projects

Eagle Canyon Bridge; Precast Deck Panels; CMGC

Projects

Echo Canyon Bridge; Slide-in; Design-Build



Projects

I-80 over 2300 East; Slide-in; Design-Build

Projects

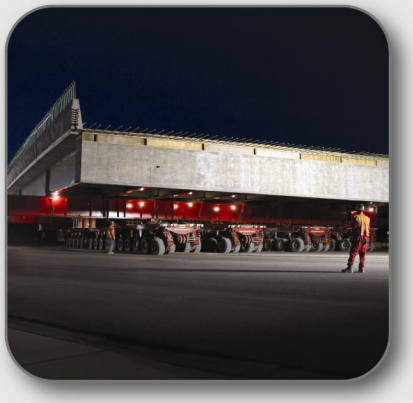
U.S. 89 over I-15; SPMT; Design-Build

Upcoming Projects

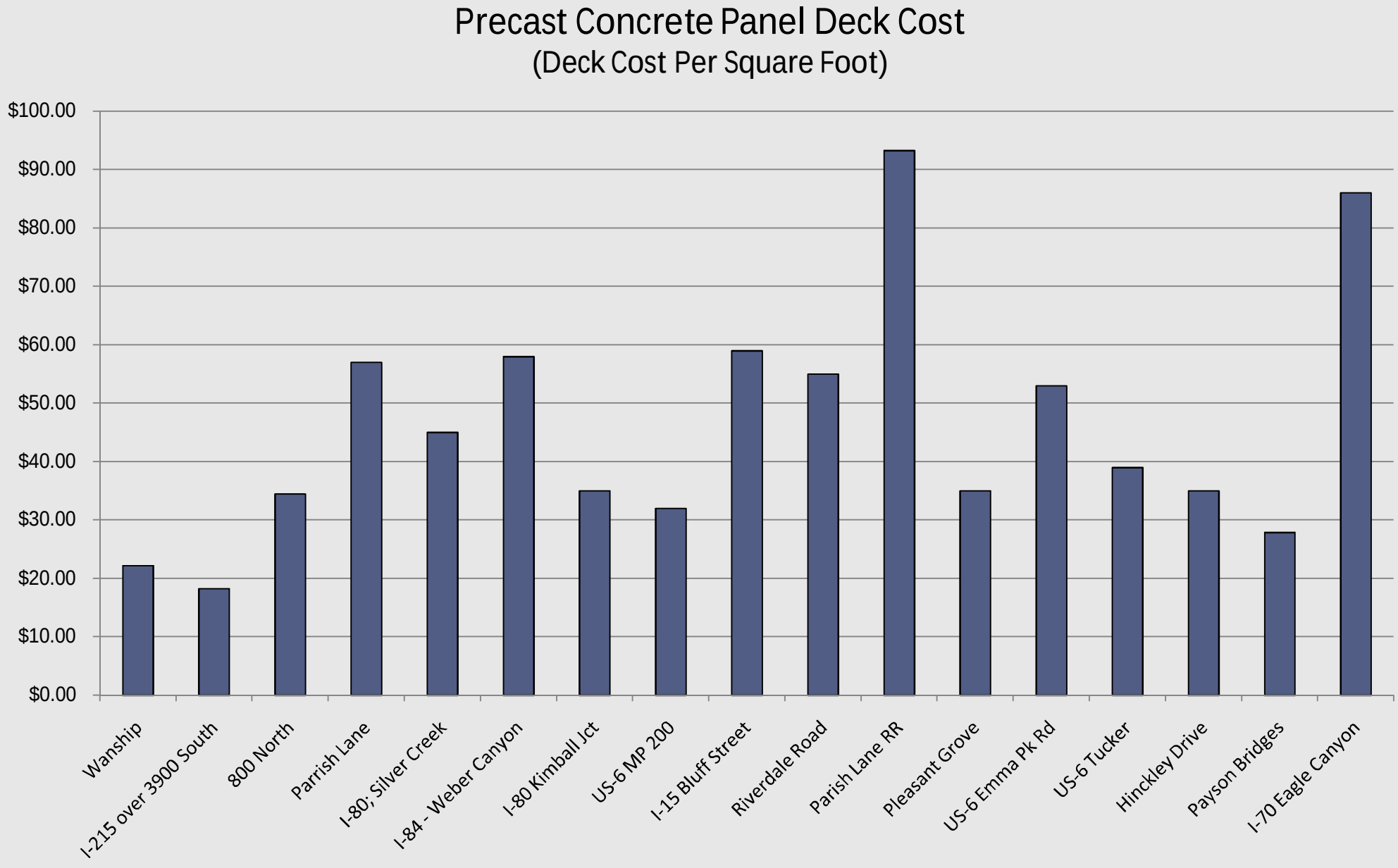
South Layton Interchange; Launch; Design-Build

Upcoming Projects

- US-6 Tucker; Lego Bridge; Design-Bid-Build
- I-80 Atkinson Canyon; Slide-in; Design-Bid-Build
- I-80 at Summit Park; ABC; CMGC
- I-15 CORE; SPMT; Design-Build

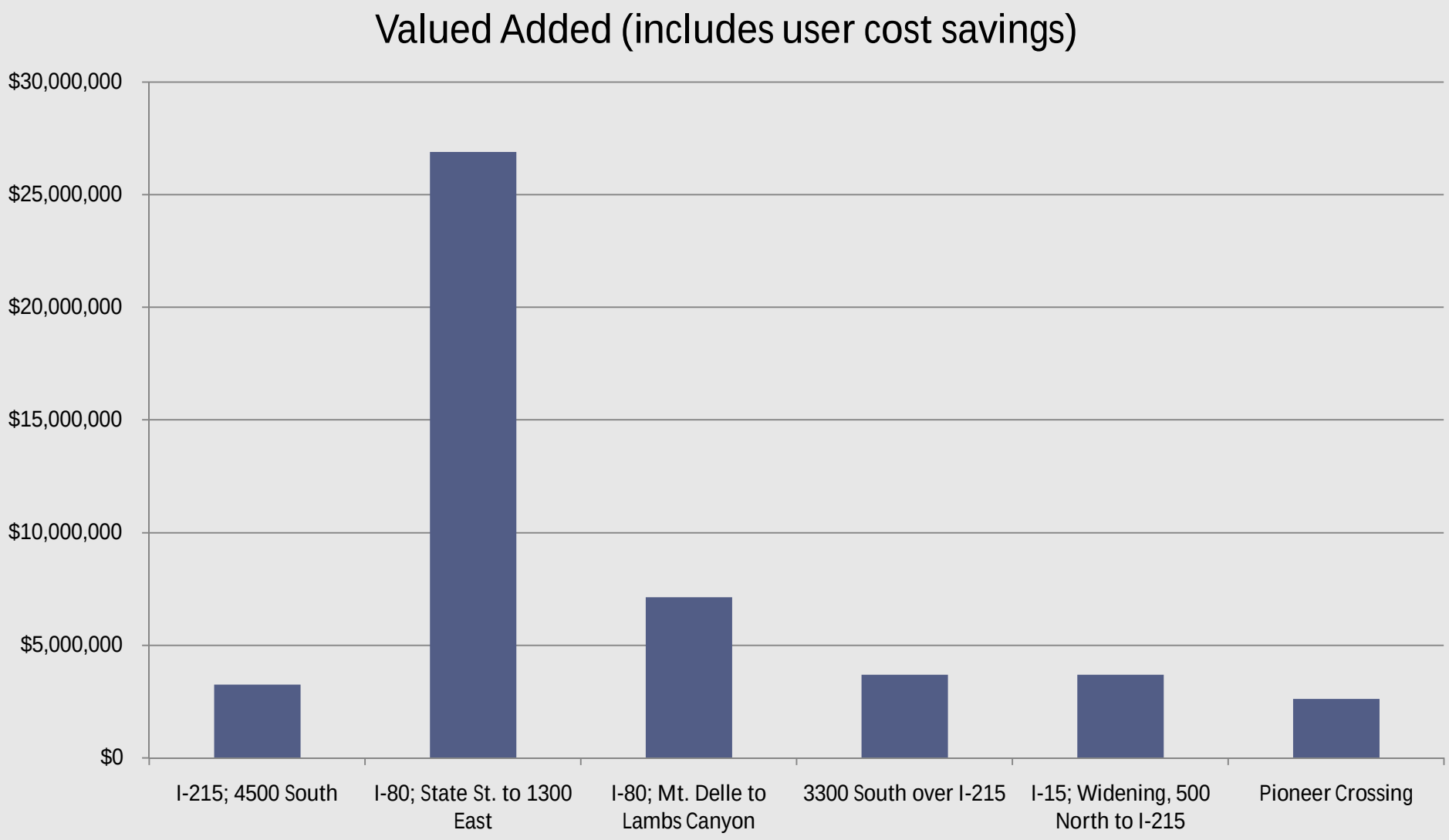


Utah ABC Costs



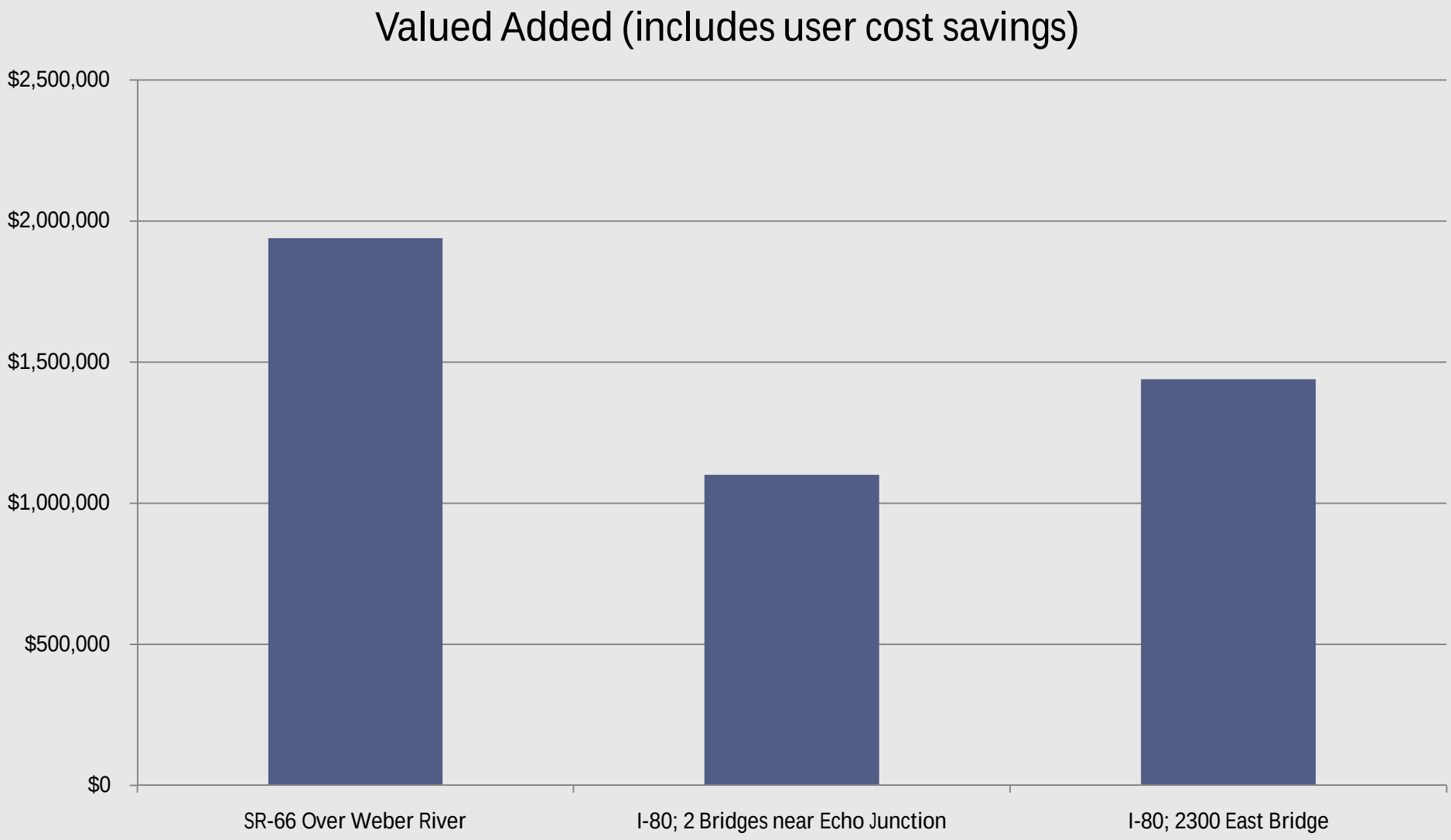
Utah ABC Costs

SPMT

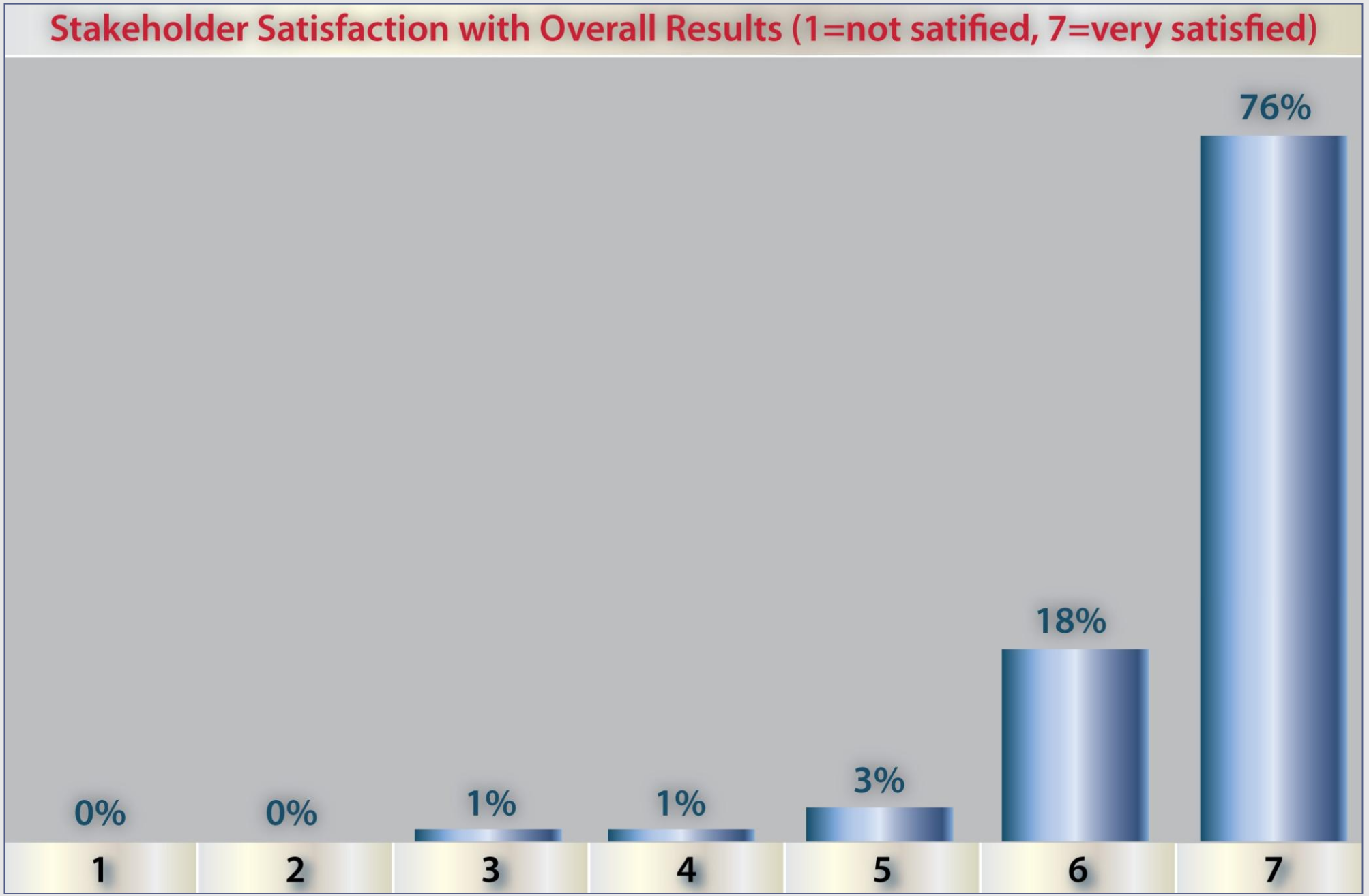


Utah ABC Costs

Slide-in



Public Support



Bridges on the Move

I-80 Parleys Canyon Bridges
SR-66 over the Weber River

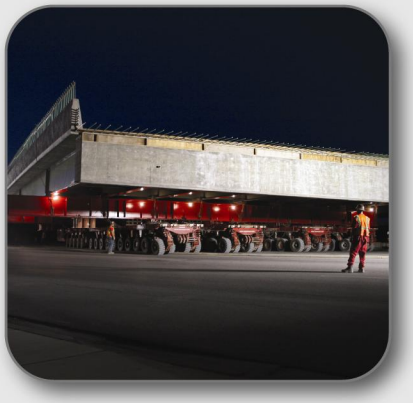
Structural Engineering

“Structural Engineering is the Art of molding materials we do not wholly understand into shapes we cannot precisely analyze, so as to withstand forces we cannot really assess, in such a way that the community at large has no reason to suspect the extent of our ignorance”

Dr. A. R. Dykes

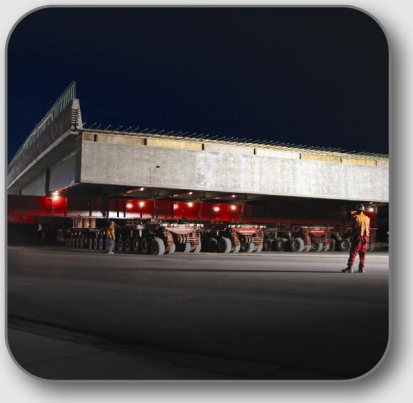
Bridges on the Move Outline

- I-80; Mountain Dell to Lambs Canyon
  - Design-Build 4 bridges with SPMT's
  - Interstate Grade Separation Structures
- SR-66 over the Weber River
  - Design-Bid Build 1 bridge using rollers



Common Project Goals

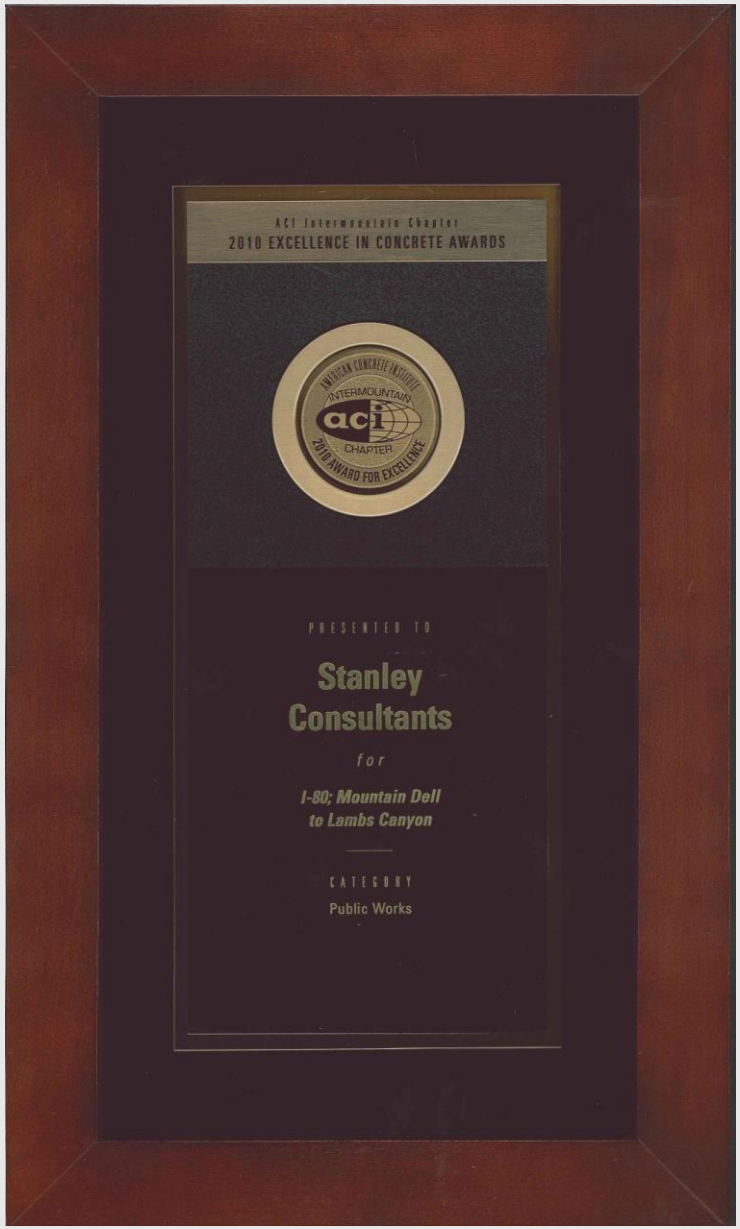
- Mitigate impacts
- Avoid move related damage
- Balance costs versus benefits



Project Differences

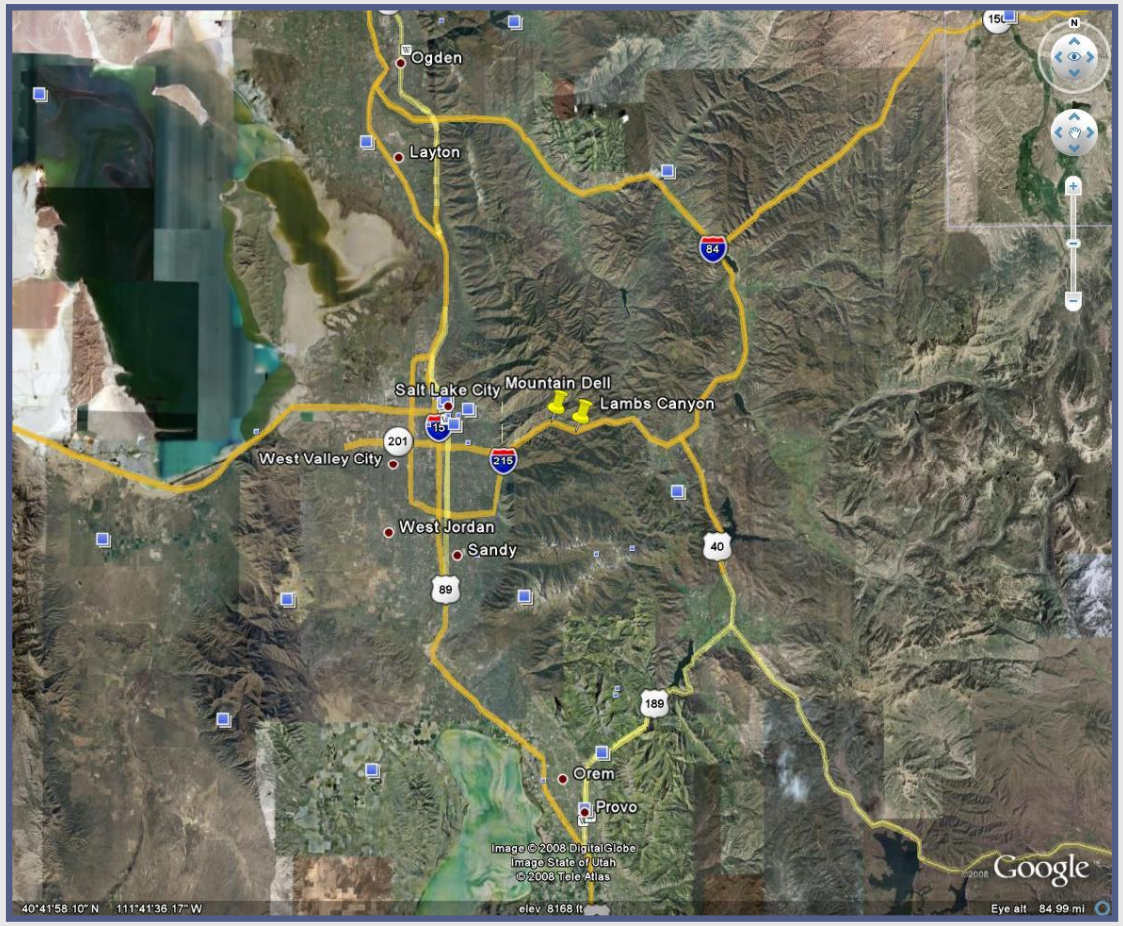
- Interstate vs. rural main street
- River crossing vs. grade separation
- Contract closure time allowance
- SPMT vs. Horizontal Skid (Hilman Rollers)
- Design-Build (I-80) vs. Design-Bid-Build (SR-66)

I-80; Mountain Dell to Lambs Canyon



I-80; Mountain Dell to Lambs Canyon

- Without detour:
  Mileage from Jct I-84 / I-80 to Jct I-15 / I-80 = 45 miles
- With detour:
  Mileage from Jct I-84 / I-80 to Jct I-15 / I-80 = 74 miles

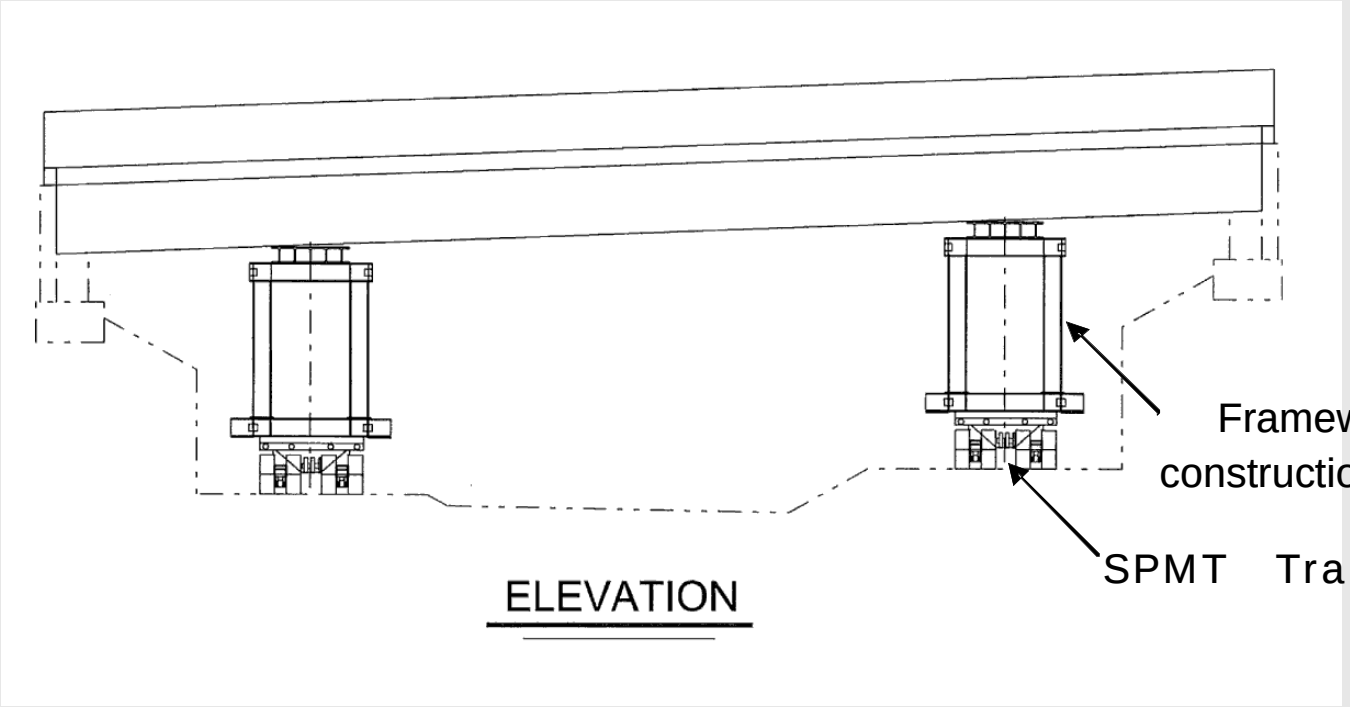


Setting the Stage for Design-Build Project

- Traffic between Salt Lake City and Parleys Summit > 25,000 vehicles per day
- Peak hourly traffic - 2079 vehicles per hour (WB), 2393 vehicles per hour (EB)
- Mountain grades between bridges are approximately 6%
- RFP allowed 16 hour full directional closure at each bridge location
- Two 24 hour full closures allowed (negotiated)
- Project scope: Replace the bridge decks
- Park City Arts Festival in August
- Utah Symphony Concert on August 17
- 70-day closures allowed of surface streets

Unique Structural Approach

- Construction Staging at Pick Points
- Deck and parapet never see tension



Mountain Dell

Mountain Dell

Mountain Dell

Mountain Dell and Lambs Canyon

Mountain Dell

New Bridge In Foreground

Mountain Dell

SPMT Staged Under Existing Bridge

Mountain Dell

Grading Design Was Tight

Lambs Canyon

SPMT Precision Moving

Lambs Canyon

SPMT Operators

Travel Path

Lambs Canyon

In With The New!!

Lambs Canyon

Close Fit!!!

Lambs Canyon

Move In Progress

Lambs Canyon

Move Completed

Lambs Canyon

Precast Approach Slab Elements

Lambs Canyon

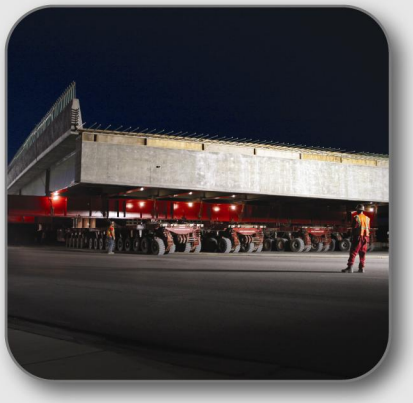
Clean Up Before Opening

Lambs Canyon

Time Lapse Photography

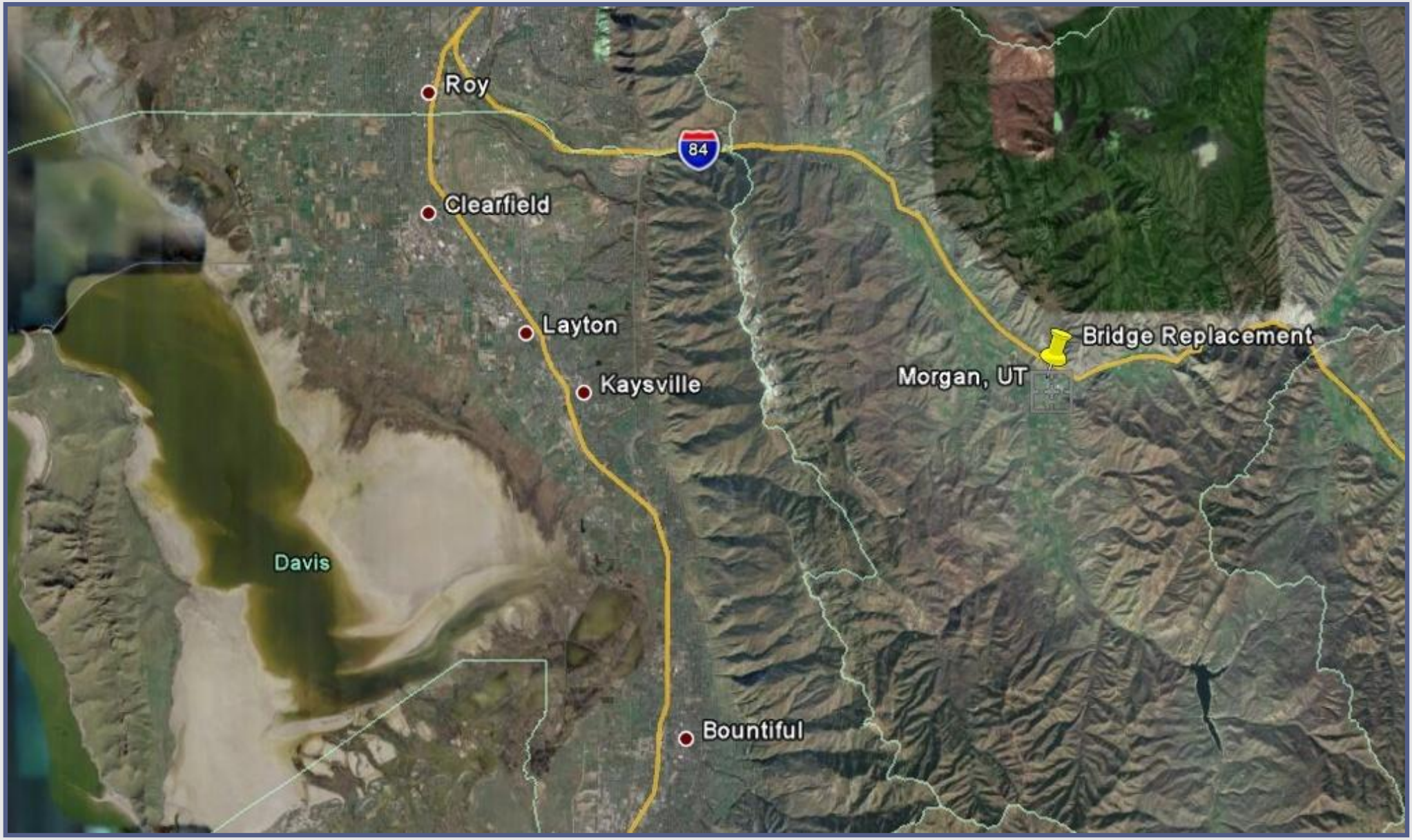
Contractor's Contract Performance

- Replace entire superstructure
- Closure time August 10, 2008 – 21 hours 20 minutes
- Closure time August 17, 2008 – 16 hours
- Closure time of cross streets < 3 weeks



SR-66 Over Weber River

SR-66 Over Weber River



SR-66 Over Weber River

Timeline/Constraints

- Advertisement: January 2009
- Construction activities restricted between May 15 and July 15
- 30 days closure of SR-66 allowed
- School traffic
- County Fair
- $10,000 per day user costs
- Existing Bridge closed on August 3
- New Bridge moved on August 7
- Traffic Restored on August 10
- Constrained structure depth

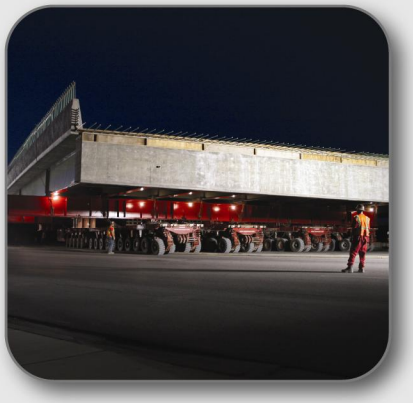
SR-66 Over Weber River

Detour Route

SR-66 Over Weber River

ABC Methods Considered

- Full-depth precast deck panels
- Bridge staging area with lifting by crane
- Precast approach slab elements
- Horizontal skid



SR-66 Over Weber River

Before Construction

SR-66 Over Weber River

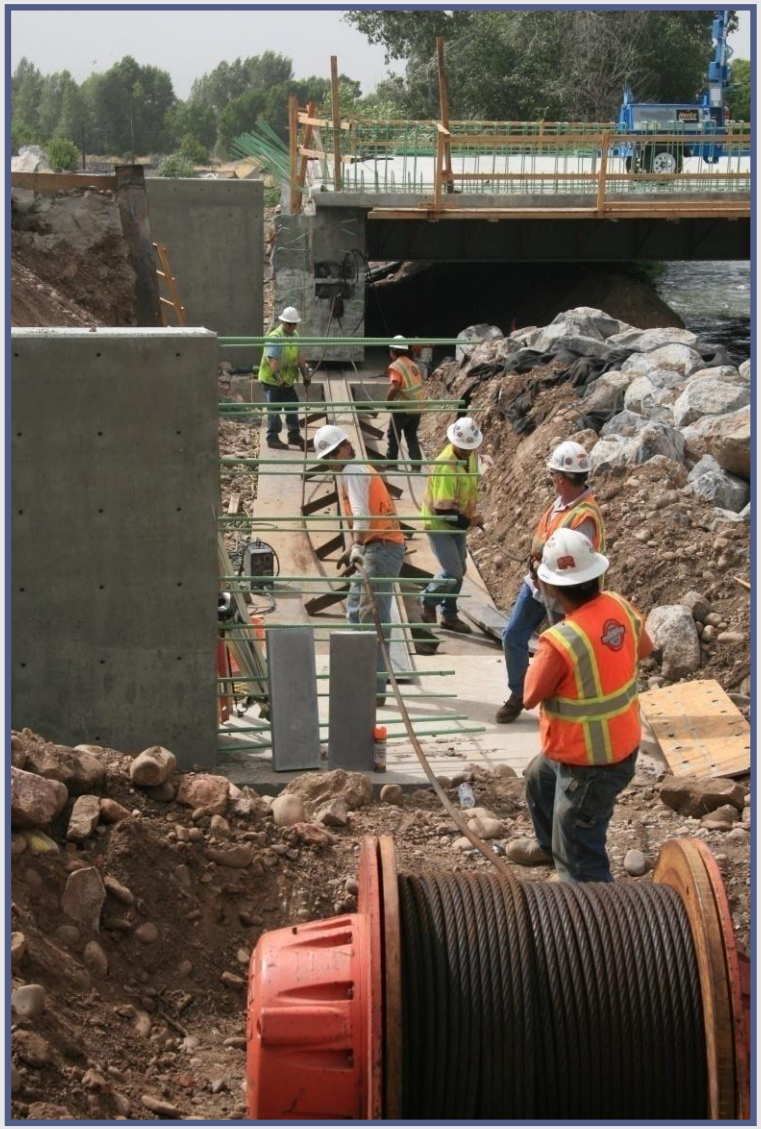
Exposed Reinforcing

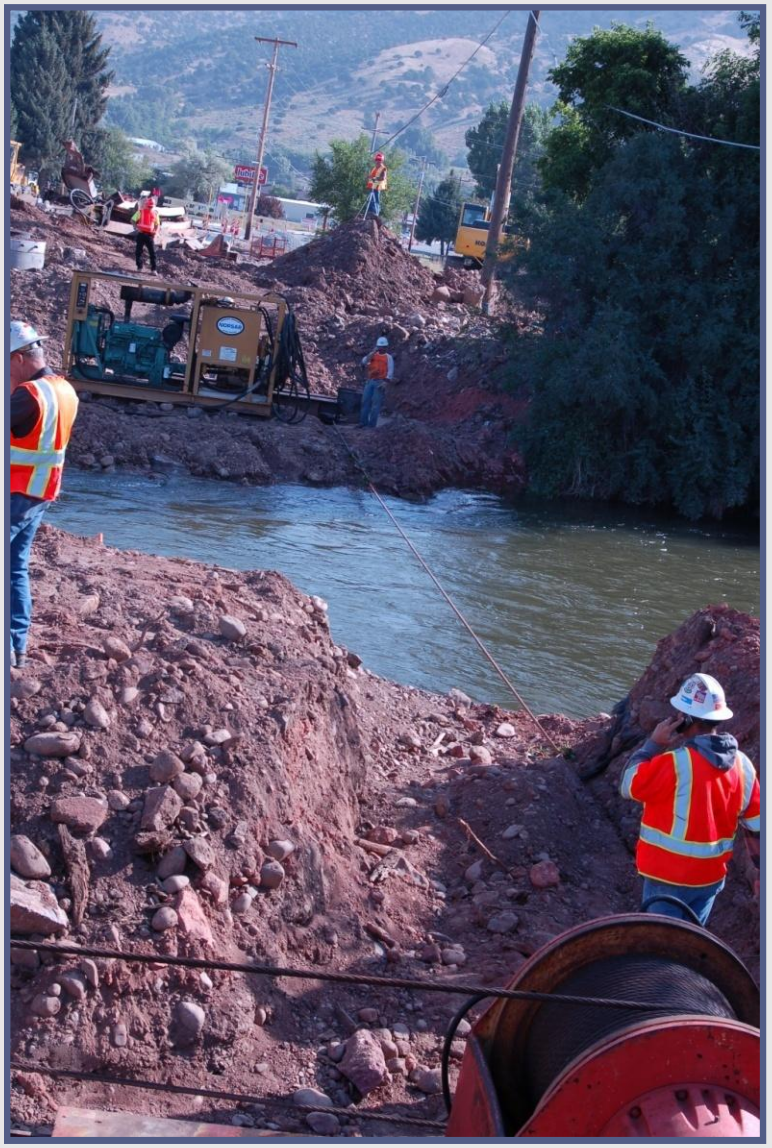
SR-66 Over Weber River

Maintenance of Traffic

SR-66 Over Weber River

The Pull



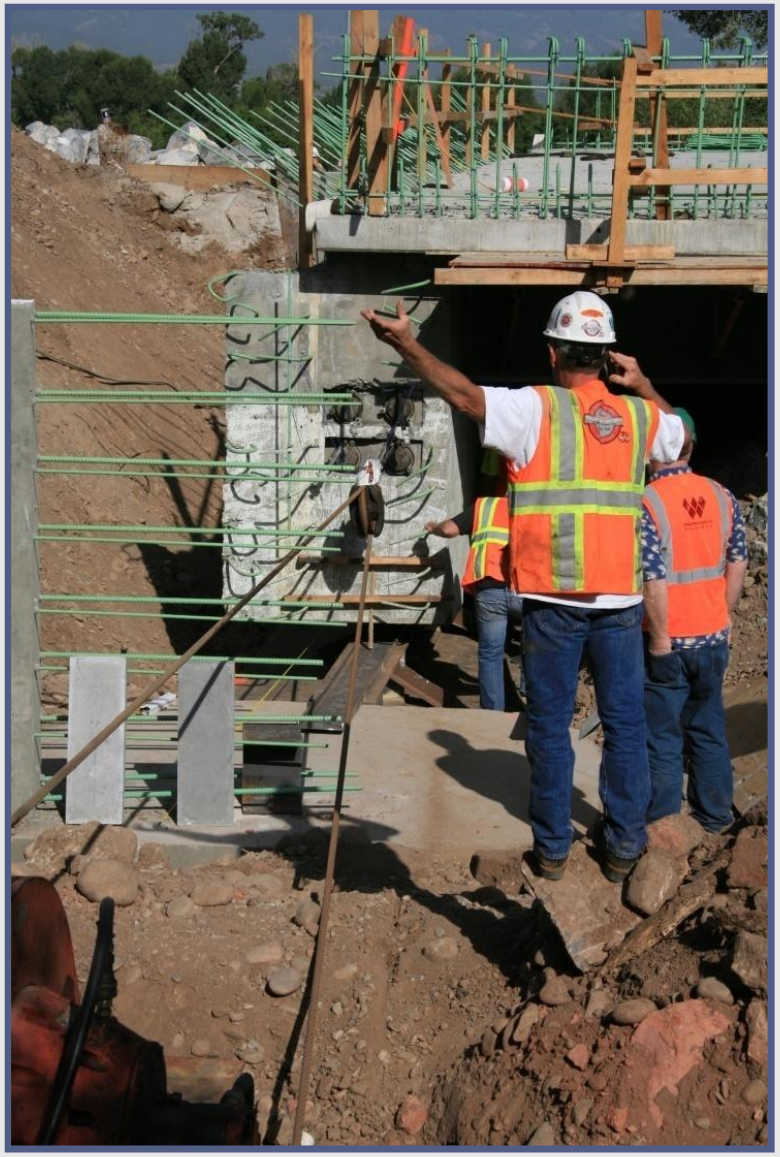


SR-66 Over Weber River

The Pull

SR-66 Over Weber River

Communications



SR-66 Over Weber River

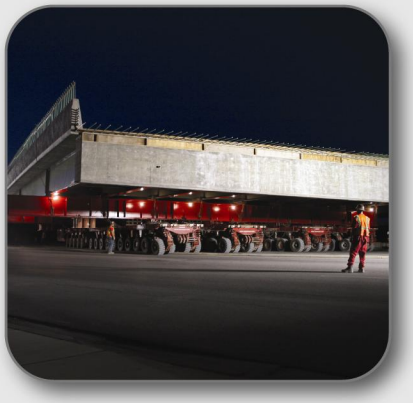
Finished Bridge


Hardware

SR-66 Over Weber River

Estimate vs. Construction Cost

- Engineer's Estimate = $2.991 Million
- Contractor's Bid Price = $1.991 Million



SR-66 Over Weber River

Time Lapse Photography

Questions?